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THE SANITARY CONTROL OF TOMATO-CANNING FACTORIES.

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CONTENTS.

	Page.
Introduction	1
Conditions observed in several tomato-canning factories	3
Washing	8
Sorting:	
Its importance	10
Sorting systems	11
Uniformity and rate of feeding	14
Turning devices	15
Lighting the sorting tables	16
Sorters	17
Volume sorted	17
Efficiency of sorting	18
Sorting—Continued.	
Cost of sorting	20
Trimming	20
Pulping	21
Pulp-making systems	21
Promptness in handling stock	23
Cleanliness in the factory:	
Its importance	24
The necessary equipment	25
Use of equipment	25
Psychology of cleanliness	26
Laboratory control	27
Summary	28

INTRODUCTION.

Marked changes in machinery and methods for the manufacture of food products have been made in the last 6 or 8 years under the stimulus of Federal and State pure food and sanitary laws. The manufacturer has come to appreciate the need for more sanitary methods. Certain individuals, firms, and corporations, of their own initiative, have blazed a path out of questionable or unsanitary surroundings in advance of Federal or State laws imposing such reforms. Much credit is due manufacturers of this type who are willing to improve their methods of manufacture regardless of the existence or nonexistence of laws making such improvements imperative. At the other extreme is that small class of manufacturers who are indifferent to the character of their product, either from the standpoint

of sanitation or from that of quality, as long as their product can be disposed of at a financial profit.

Between these two extreme types of manufacturers, one of which is alert and active in seeking constantly to improve conditions, and the other of which is devoid of care or interest in the business beyond the financial profit obtainable, there is a third and much larger class. This class comprises those men who are willing to make improvements in keeping with sound, sanitary practice, but whose experience, because of the purely commercial aspects of their business, has given them no opportunity personally to study the sanitary problems of their factories and to apply the information gained in a practical manner. In other words, many manufacturers are deterred from making improvements because of lack of knowledge either of the fundamental reasons for such improvements or of how to proceed.

The willingness of this class of manufacturers to make improvements, however, has rendered possible the great changes that have taken place in recent years in mechanical contrivances for cleaning and handling the various products used in the manufacture of foods. This progress is especially well illustrated in the tomato industry. For example, only a few years ago the sorting of tomatoes in the manufacture of ketchup and pulp was very uncommon, while to-day very few manufacturers do not at least profess to observe this step, however ineffectively the process sometimes may be performed. Various forms of tables and machines have been devised to assist in this important step of manufacture. Many forms of tomato-washing machines found in common use 6 or 7 years ago have become so obsolete that they are being consigned rapidly to the scrap heap as inadequate to meet present-day requirements. Processes, such as the "gravity system" of draining off the watery juice from pulp which was so very largely practiced less than 10 years ago, have been discarded by firms that are trying to keep abreast of their fellow manufacturers in matters of sanitation and quality. The custom of storing in barrels—general a few years ago—has now practically disappeared, except for the poorest grades of products. The barrel has been replaced by the 5 or 6 gallon tin can. The writer recalls having seen at one plant thousands of barrels in one lot being offered for sale because the firm had no further use for them, as it had adopted the more satisfactory system of storing its product in cans.

The manufacture of sanitary food products is too broad a problem to be covered in one publication. In the present bulletin the discussion will be limited to those conditions which apply particularly to tomato-canning factories. It is proposed to discuss some of the more important points concerning sanitary control of plants of this kind in a rather elementary manner and to avoid technicalities as far as possible.

CONDITIONS OBSERVED IN SEVERAL TOMATO-CANNING FACTORIES.

Criteria of cleanliness are involved in the question of what constitutes a sanitary plant or product. Under the Food and Drugs Act, June 30, 1906, the Federal Government has no power to enforce sanitary rules except as it may prohibit the entrance into interstate commerce of products which are filthy, decomposed, or putrid.[1] Direct control over the factories themselves is wholly within the jurisdiction of the several States; the Federal Government can serve only in an advisory capacity. Various States have sanitary regulations, but in formulating them general terms must be used. Hence, in applying these regulations to specific cases considerable difference of opinion may appear because of the variation in training or experience of those making the inspection. It is easier to direct that "products shall be made in a sanitary manner" than to explain in concrete terms what is meant by these words. Therefore, it seems appropriate to tell of the conditions found in a few factories and what was done to correct them. These examples are cited not because they represent the average condition of tomato-canning factories throughout the country but because they illustrate conditions in a rather large class of establishments where the superintendents are sincere in considering their plants satisfactory when, as a matter of fact, their factories may be seriously deficient in some particulars.

At hearings held in connection with the enforcement of the Federal Food and Drugs Act it has occurred repeatedly that the manufacturers concerned have claimed that their products were made under absolutely sanitary conditions. Obviously, it is rarely possible to verify such statements by inspection, principally because the season when the goods were packed has already passed and the factory is more or less dismantled. Usually it is of little value to visit a plant in the out-of-season periods of the year if a study of sanitation under working conditions is desired. Such claims on the part of the manufacturers usually may be considered as candid and honest expressions of opinion, but field work has shown that lack of experience in matters of sanitation may produce very erroneous conclusions.

Factory No. 1.

About the middle of a recent tomato-packing season the following letter from a manufacturer of tomato products was received by the Bureau of Chemistry:

We wish to call your personal attention to a condition that is existing in the tomato-ketchup business as regards our own plant and, as we believe, the same condition exists in many other plants.

[1] For the views of various Federal courts upon what constitutes a filthy, decomposed, or putrid product see Notices of Judgment 544, 649, 825, 873, 1693, 3372, 3400, and 4036; also National Canners Asso. Bul. 38, Jan. 20, 1917, Washington, D. C.

We are getting from the farmer a high-grade tomato, one that is perfectly sound and ripe. We are trimming our tomatoes very carefully and washing them in three different waters.

Reports from our chemist * * * showed our earlier run to be:

Mold.	Yeast and spores.	Bacteria.
In 7 per cent of fields...	6 in 1/60 cmm.....	10,500,000 per cc.
In 9 per cent of fields...	7 in 1/60 cmm.....	9,500,000 per cc.

Since then it has been gradually increasing until our last report shows the following:

52 per cent of fields.....	28 in 1/60 cmm.....	21,000,000 per cc.
44 per cent of fields.....	28 in 1/60 cmm.....	24,000,000 per cc.

It is absolutely impossible for any human being and under any conditions to take tomatoes and manufacture a ketchup any more cleanly, any freer from mold or bacteria than the ketchup we are producing. There isn't a ketchup factory in the United States more cleanly or sanitary than ours. We are satisfied that this mold, yeast and spores, and bacteria is in the tomato in its healthy condition, that is, in perfectly sound tomatoes.

We know no one would condemn these tomatoes as being unfit for food. We are endeavoring to comply with the food law standard that has been established on tomato ketchup, but we can not go out of business simply because these standards have been made without due knowledge of the real chemical analysis of a perfectly sound, fresh tomato under all conditions, and when the raw product brought from the farmers is delivered to our plant and handled in a perfectly sound, clean, wholesome condition, we can not understand why our goods, which are strictly high-grade and pure, should be condemned by the Department of Agriculture under conditions of this kind.

We will very much appreciate if you will wire us just what to do. Also that you would have one of your representatives at our plant as quickly as he can get here, as we feel that we are entitled to the services of one of your personal representatives, as we know that our goods are right.

We know that they can not be manufactured under any more cleanly conditions than we are carrying out. We are therefore willing and entitled to make a stand on this, believing that the Agriculture Department will recognize the condition and protect us against any results that might come from our goods being picked up by food inspectors among our customers after they have left our warehouse.

Thanking you, and trusting that you will give this your immediate attention, we are,

Yours very truly,

———— ————.

The appeal in the letter enlisted the interest of the bureau and produced a desire for a careful investigation of the conditions complained of. Accordingly, the senior writer made a visit to the plant. It was the only factory in a small country town of about 100 inhabitants. Most of the employees, both men and women, came from the surrounding rural district. A stay of several days was made at the plant and various tests were conducted.

Examination of the sorted tomato stock showed that although at times it was not above criticism, poor sorting probably was not the main source of the trouble. The irregularity of sorting might have been due in part to the poor lighting of the sorting table. Observation of the method of cleaning the equipment at the end of the day's run, however, showed that the various parts of the washers, conveyors, cyclones, and pulp tanks were being only superficially cleaned. By reason of the method of construction or of the inaccessible location of the general equipment, some of its parts contained accumulations of tomato material fairly teeming with microorganisms.

Three cyclones were in use in this factory. The pulp tanks of two of these cyclones were connected with that of the third by means of wooden pipes. Examination of the inside of these pipes showed a thick growth which was so heavy in molds as to give a count of 100 per cent of the fields even after diluting 18 times. It was swarming with bacteria and yeasts and had an offensive, fetid odor. A count of bacteria gave over a billion per cubic centimeter. In other parts of the equipment the bacterial count went to a billion and a half and nematode worms were found in numbers as high as 1,080 per cubic centimeter. Yeasts and spores were present in numbers up to 4,000 per 1/60 cubic millimeter.[1] Examination under the microscope of a portion of the slimy coating showed it to be largely a mold growth with a mass of tomato débris and quantities of bacteria. Plate I shows photomicrographs of the mold. A specimen of it was identified[2] as composed largely of a type of mold called *Oidium lactis*. When grown under such conditions as found in this factory it assumes an elongated, feathery form which is quite distinctive in appearance from that of the mold which grows on tomatoes.

In the examination of some samples of tomato products this characteristic type of growth has been of practical use in indicating the existence of foul or dirty factory conditions.

Inspection of the cleaning equipment of the factory showed that it was entirely inadequate. Too great reliance was being placed in the supposed efficiency of the steam hose, and there was lack of other proper cleaning apparatus. The cleaning process also was made more difficult because rough lumber had been used for flights on conveyors, for paddles of the cyclones, and in other places. In addition to these difficulties some of the corners were inaccessible and poorly constructed. After suitable cleaning utensils were obtained and certain changes made to facilitate the cleaning operation for the work-

[1] Under proper factory conditions it is possible to maintain the following maximum counts: Mold in 25 per cent of the microscopic fields; yeasts and spores per 1/60 cubic millimeter, 25; bacteria per cubic centimeter, 25,000,000. (See U. S. Dept. Agr., Bur. Chem. Circ. 68, Tomato Ketchup under the Microscope, pp. 4, 5, 6.)

[2] By Dr. Charles Thom, Bureau of Chemistry.

men the high count was immediately lowered and remained low during the rest of the visit.

Tests of the ketchup manufactured by this factory were made periodically during the stay and were distributed over 8 days. The first four tests were made prior to the general cleanup. The sample used in the fifth test was taken from the first batch of ketchup made after the cleaning was completed. About one-third of the molds in this sample were distinctly of the form which indicates dirty apparatus. They were the filaments dislodged during the cleaning process which had not been fully rinsed out during the washing and hence were carried over in the first kettleful of the product. The last four tests were made during the next three days.

TABLE 1.—*Microscopical examination of tomato ketchup before and after the installation of adequate cleaning equipment and methods.*

Test No.	Per cent of fields with molds.	Bacteria; million per cubic centimeter.	Yeasts and spores per 1/60 cubic millimeter.
1	45	40	65
2	66	60	57
3	64	52	52
4	54	43	56
Average before cleaning	57.2	48.7	57.5
5	30	9	21
6	16	10	15
7	21	10	10
8	15	8	7
9	20	7	13
Average after cleaning, excluding No. 5	18	8.7	11.2

A study of Table 1 emphasizes the change in the counts between those made before and those made after cleaning, in that the counts have been reduced in the case of mold to about one-third and of bacteria and of yeasts and spores to about one-fifth.

The question may arise in the minds of some readers as to whether the marked change shown in the counts might not have been the result of other influences than the cleaning. The only other change made was a minor one in the system of sorting. In Table 2 are given the results of efficiency-of-sorting tests. The method of making these tests is described in detail on page 18. The tests were made on the sorted and washed stock ready for the crusher and represent the approximate percentage of decay that was going into the finished product. The data in Table 2 show that the average percentage of decay during the first 5 days was 1 per cent, while during the last 3 days (the after-cleaning period) it was 0.94 per cent. Obviously these figures are negligible in accounting for the marked changes observed in the counts.

TABLE 2.—*Efficiency-of-sorting tests.*

Date.	Hour of test.	Percentage of decay.	Date.	Hour of test.	Percentage of decay.
Sept. 22		2.20	Sept. 26	8.00 p. m.	0.37
Do	9.30 p. m.	1.60	Do	10.15 p. m.	.93
Do	10.45 p. m.	1.50	Sept. 29	10.00 a. m.	1.70
Sept. 23	11.45 p. m.	.81	Do	5.30 p. m.	1.35
Sept. 24	9.15 a. m.	.87	Do	8.00 p. m.	.50
Do	5.00 p. m.	.50	Do	8.30 p. m.	.43
Do	9.00 p. m.	.50	Do	11.00 p. m.	.75
Do	11.30 p. m.	1.10	Sept. 30	10.30 a. m.	.75
Sept. 25	10.00 p. m.	.75	Do	11.40 a. m.	.55
Sept. 26	11.45 p. m.	1.10	Do	7.30 p. m.	1.00
Do	3.45 p. m.	1.00			

During the visit at the plant personal attention was given to the cleaning operations. Wherever possible without handicapping the operations of the factory, changes were made by which the apparatus was more easily and effectively reached for cleaning. In some cases wooden piping was changed, doors put in conveyors, pulp boxes made removable, and other changes were made by which the workmen could clean the various parts more quickly and efficiently.

After these improvements had been made a change was noticed in the odor about the factory, especially when the steam hose was in use. The offensive, fetid odor, which had been noticeable in the rising vapors whenever the steam hose was used, almost wholly disappeared, and in its place came the characteristic odor of fresh tomato pulp.

Factory No. 2.

A faulty sorting system was the cause of the high counts present in the product manufactured by another factory visited by the bureau's representatives. This condition is more general than the existence of inadequate cleaning systems.

It was brought to the attention of the Bureau of Chemistry that this factory was having difficulty in maintaining low counts on its products. On visiting the plant it was found that the tomatoes were dumped into a soaking tank, from which they were carried up by a conveyor and fed into a rotary washer, covered with a screen of too fine a mesh to allow its being as efficient in removing soft rot as is necessary. From this washer the tomatoes were fed to the sorting apron. This apron was so arranged that at intervals along its length a portion of the main stream of tomatoes was diverted through the scalding boxes and out upon the peeling tables. Three sorters were working at the main sorting apron, but were so stationed that the tomatoes diverted to the first table received little or no sorting inspection. Those for the second table received some attention, while those for the third had the greatest amount. The sorters also were trying to do trimming work. The result was that many spotted tomatoes

were not sorted out. Tests made for the percentage of rot in the sorted stock showed it to vary from about 0.1 per cent to over 2.5 per cent of decayed material. The apron was moving at a rate of 78 feet per minute. During the three days that tests were made at the plant several changes were instituted, among which were slowing down the rate of the apron, securing more women for the inspection service, and dividing them into squads. One squad did nothing but sort out the spotted tomatoes and put them in buckets the contents of which were trimmed by the second set to remove the rot. Tests on the efficiency of sorting under the changed conditions gave a range of from no appreciable amount of rot to 1.3 per cent.

Factory No. 3.

A visit made to still another plant, some of the product of which had been condemned the previous season, showed that the tomatoes were passing through one of the washers and scalders at the rate of 490 bushels per hour. Five young boys, between the ages of 13 and 15, were working at the sorting table. A test of the stock being fed to the sorting table gave about 16 per cent of rotten material. A similar test after sorting gave about 7.5 per cent. All the waste from the tomatoes removed at the peeling tables went into the cyclones for pulp making.

WASHING.

During the last few years various systems and devices have been tested under factory conditions and a mass of data has been collected bearing upon so many of the practical questions concerned in the production of a clean, sanitary product that it is proposed to discuss here the more important of these operations.

Any one familiar with the canning industry must have noticed the changes that have taken place in recent years and the improvements that have been made in tomato-washing machinery. The choice of a proper washing system requires a knowledge of the specific conditions under which the system is to be operated in each case, since a system that works satisfactorily under one set of conditions may be inadequate elsewhere.

In some parts of the country tomatoes are grown on a soil which has an abundance of sand in it and little clay. Tomatoes grown on such land are fairly readily cleaned by a good spraying apron washer. In other parts of the country the soil consists of a sticky clay loam, which clings so tenaciously as to make its removal by the spraying system alone very difficult. In such cases some sort of rubbing method is highly desirable. It is under such conditions that the rotary washers are efficient. Factory owners sometimes have been found who have been deceived as to the efficiency of their

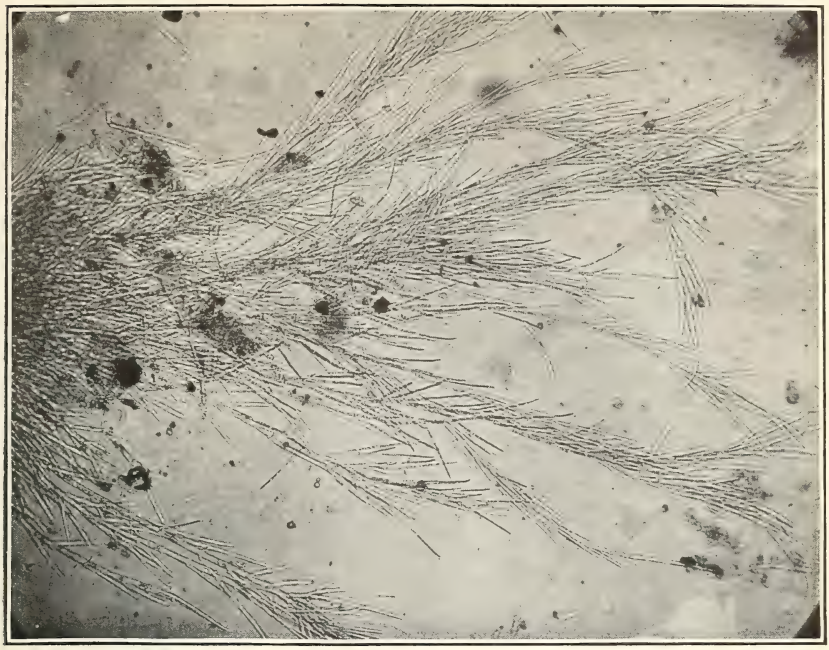

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FIG. 1.—MOLD FROM SLIME ON INSANITARY APPARATUS. (MAGNIFIED 100 DIAMETERS.)

Note the feathery character.

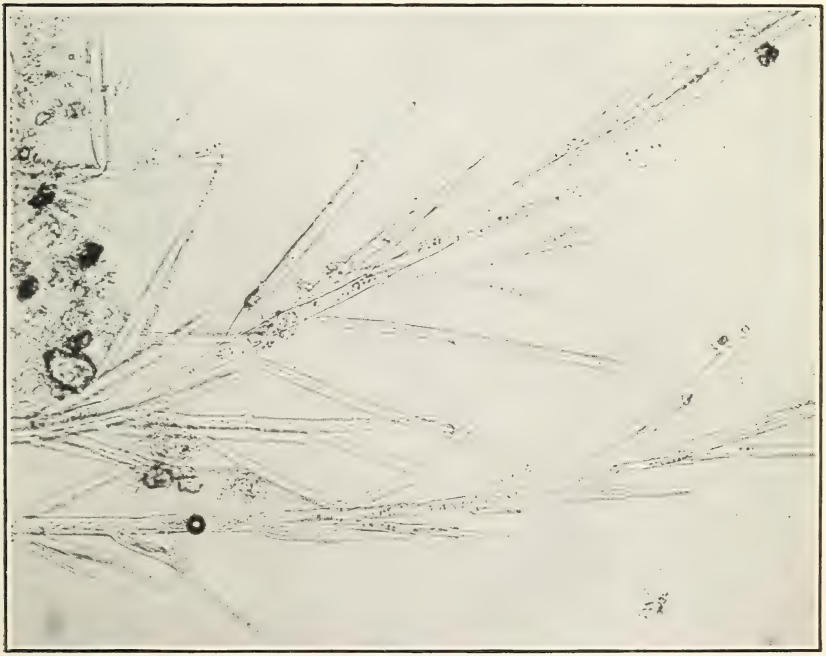

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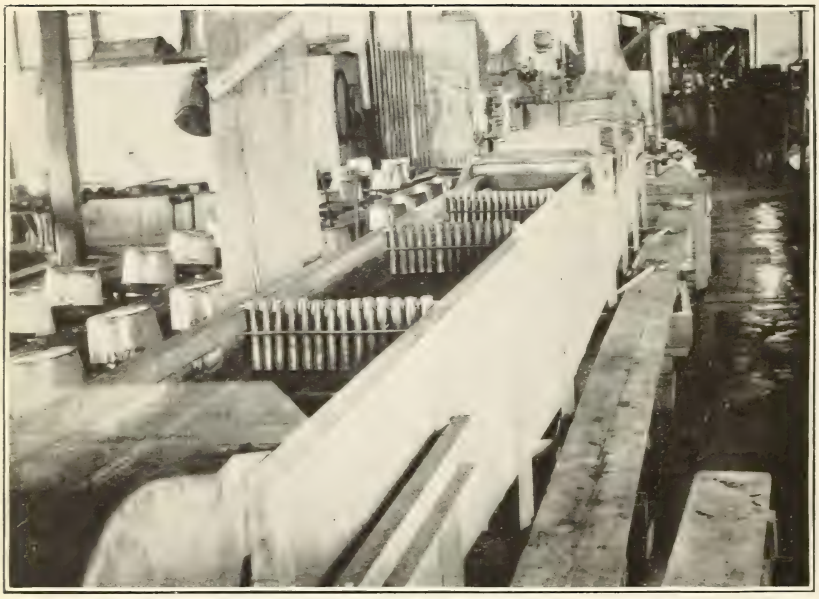
FIG. 2.—MOLD FROM SLIME ON INSANITARY APPARATUS. (MAGNIFIED 300 DIAMETERS.)



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TOMATO TURNING DEVICE ADAPTED TO SIMPLE APRON SORTING TABLE.

washers, because a thin coating of dirt on the skin of a tomato is less evident when the tomato is wet than when it is dry. Tomatoes that may appear fairly clean when wet may still show a thin, adhering coat of soil if allowed to dry.

The principal types of washers in use are the following: (*a*) dump hopper; (*b*) worm (helicoid); (*c*) spray apron; (*d*) rotary; (*e*) paddle agitator; (*f*) air blast (geyser); (*g*) cascade.

(*a*) The dump hopper is now used by only a few small packers. It has practically nothing to recommend it as a washer.

(*b*) The old-style helicoid worm washers also are being replaced rapidly by the more modern types.

(*c*) In the plain apron washer the tomatoes are carried on an open-work apron through an inclosed chamber in which are strong sprays that strike the tomatoes at various angles. This type of washer does satisfactory work provided the water pressure is high enough (some advise 100 pounds or more per square inch), and the soil on which the tomatoes are grown is not of a very sticky character. If a high pressure is used the apron washer assists materially in eliminating soft rot spots, although, of course, it should not be expected to do the work which properly belongs to the sorters. The type of nozzle used on these machines, however, offers opportunity for improvement. A nonclogging, flat spray form is much needed. The common spray form of nozzle usually employed does not deliver the force of the water evenly. Since the water is delivered in a circular form the tomatoes passing along the edges of the circles get the force of the stream for a longer time than those going through nearer the center. The orifice of emission of the water in this type is so narrow that it clogs quickly unless the water supply is very free from solid particles such as scale from the inside of the water pipes. Nozzles working on the impact principle do not seem to be so subject to these objections.

(*d*) The rotary washer consists of an inclined cylinder covered with a wire screen of 1-inch mesh. It is very commonly used and generally gives good results. Its advantages are that it rubs the tomatoes against each other, thus loosening the dirt, and it does the washing with a less expenditure of water than most of the other washers that give satisfactory results. Furthermore, it will remove some of the soft-rot tomatoes. The principal objection urged against it is that the manner of its operation tends to crush some of the very ripe tomatoes, which may be sound but so ripe as to be tender.

(*e*) In the paddle-agitator washer the tomatoes are dumped into a tank of water where they float and are agitated by slowly revolving paddles, which cause the tomatoes to rub against each other, thus loosening the dirt. At the same time the tomatoes are worked along toward the conveyor, which removes them from the tank. As they

are carried out they pass under water sprays which give them a final rinsing.

(*f*) The air-blast or geyser washer works on the same general principle as the preceding type, but produces the agitation by blasts of air entering the tank at or near the bottom.

(*g*) In the cascade washer the tomatoes are carried up a tight-bottomed conveyor inclined at an angle of 30° to 50°. Near the top are the inlets for water which emit a sufficient amount to produce a vigorous flow down over the ascending stream of tomatoes. Although it is a good rinser, it is not sufficient alone to remove thoroughly the sticky soil from the fruit.

SORTING.

ITS IMPORTANCE.

A careful consideration of the causes of failure in making clean, sound, sanitary tomato products shows clearly that more difficulty is experienced in effecting satisfactory washing, prompt handling, and efficient sorting than in any of the other phases of the manufacturing process. Sorting is the most important of these operations, in which the judgment of the workman plays a considerable part. Satisfactory washing is largely a question of proper operation of a mechanical device. This may be said also of many of the other operations about the factory, but so far no mechanical contrivance for separating the decayed from the good parts of the tomatoes has been placed upon the market. This operation must still be performed principally by hand. Although some washers, if properly constructed and operated, will assist in removing the badly soft-rotted tomatoes, efficient hand sorting must be employed if a uniformly good, sound product is to be obtained.

Experience has shown that in factories where the tomatoes are used only for peeling stock and where all the trimmings are thrown away sorting is an unnecessary expense. In the making of pulp of any kind, however, efficient sorting is absolutely necessary. Otherwise there can be no assurance of producing a uniformly sound product with low counts of microorganisms.

The conditions observed and the results obtained in various factories show that there is little, if any, choice between sorting the tomatoes before and after washing. Some of the best, as well as some of the poorest, results were obtained in factories where one or the other of these methods was employed. Approximately two-thirds of the plants visited during the seasons of 1915 and 1916 that did any sorting at all were using the wet method, and one-third the dry method. In order to remove clinging pieces of partially decayed tomatoes, the tomatoes always should be subjected to a washing or

rinsing after sorting, even though the principal washing has been done before sorting.

SORTING SYSTEMS.

The various sorting systems in operation may be designated as (*a*) table, (*b*) simple apron, and (*c*) divided apron. These systems are not kept entirely distinct, however, but frequently overlap in one particular or another.

(*a*) In the typical table system the tomatoes are dumped upon a stationary table or sorted directly from the crate or basket. The tomatoes are picked out by the sorters who are stationed around the table, and after being examined are tossed into suitable containers, from which they are emptied from time to time into the washers. The decayed tomatoes or parts thereof are removed and rejected. One advantage of this system is that by examining the sorted stock in each container the efficiency of the individual sorters can be determined more readily than by any of the other systems. As a rule it is a fairly effective system, but usually is more expensive than any of the others.

(*b*) In the simple apron conveyor system the tomatoes are placed upon a slowly moving, horizontal apron which carries them along in front of the sorters, who are supposed to remove all tomatoes that are entirely or partially decayed. Those not picked out constitute the stock finally used in the manufacturing process. By this system the tomatoes theoretically are subjected to as many inspections as there are sorters to the apron. With good sorters and where proper conditions of feed, rate of movement, and lighting are maintained this is practically true, but emphasis must be laid upon the observance of these details if satisfactory results are to be attained.

Under normal conditions, where proper attention is given to details of feeding and lighting, the apron conveyor system has been found to yield as good results as any that has been devised. This is true for two reasons. In the first place, only those tomatoes that have decayed parts need to be picked up and taken out. During the last two seasons more than 100 tests were made on the unsorted stock in about 30 different factories in various parts of the tomato-producing sections east of the Mississippi River. These tests have shown that from 0.4 per cent to 81 per cent by number of the tomatoes were decayed, in whole or in part, to such an extent as to require trimming or total rejection. The average by number was about 25 per cent. This means that in an average bushel[1] of tomatoes 58 must be removed and rejected either in whole or in part.

The second advantage of this system is that if one of the sorters is inexperienced or becomes a little lax in the work the fault is more

[1] The average number of tomatoes per bushel as determined by 174 tests made in 1916 was 229.

likely to be compensated for by the carefulness of the other sorters than in the case of any of the other systems. This, however, should not be used as an excuse for putting unreliable sorters on the apron.

The width of aprons used varies greatly, ranging from 8 inches to 4 feet. To get the best results the aprons should be narrow enough for the sorters to reach easily across the entire width. The most convenient and practicable width has been found to be from 18 to 20 inches.

Even greater variation is found in the rate of movement of the apron. Tests on the rate of speed in different plants showed a minimum rate as low as 16 feet per minute and a maximum as high as 140 feet. The speed of the apron should be retarded sufficiently to permit careful observation of the individual tomatoes and to allow the sorters sufficient time to reach for and remove those with rotten spots. Observation of a large number of sorting aprons in operation has shown that it is impossible to obtain good results with a speed exceeding 25 feet per minute.

(*c*) In the divided-apron system the tomatoes are dumped upon a conveyor very similar in construction to the simple apron, but usually somewhat wider. Over this conveyor a guide is suspended which divides the stream of tomatoes into two parts, one on each edge, and leaves also a vacant space through the center of the apron. The sorters stand beside the apron, pick out the good tomatoes, and toss them over into the middle section of the apron. All the tomatoes not thrown over into the middle section pass into the waste at the end of the machine. The good tomatoes pass on into washing or rinsing systems. A modification of this system is to remove the bad or spotted stock to the middle section from which they pass into the waste.

Each tomato, theoretically, is subjected to a scrutinizing inspection, but actually, when the sorters are inspecting rapidly, they will pick up some of the tomatoes and toss them into the center without taking the trouble to turn them over to see the underside. The fact that by this system all the tomatoes, both good and bad, must be actually handled contributes materially to the inefficiency of the system, as about 75 per cent of the entire stock are sound. It necessarily follows that, as a rule, a larger corps of sorters will be needed than in the simple apron system, where only tomatoes with decayed parts have to be handled.

In constructing a sorting apron of either type the manufacturer's first problem is to plan one that will meet his requirements as to capacity. A number of tests made on the area a bushel of tomatoes will cover when laid out in a layer one tomato deep showed that, in general, the larger the tomatoes were the smaller was the area covered. The tests made showed a variation of from approximately 7 to

12½ square feet per bushel, with an average of about 9⅓. As the tomatoes should be fed onto the apron so as to leave at least one-half of the space uncovered, a space of about 18½ square feet should be provided for each bushel. This would mean that a sorting apron 18 inches wide and moving at the rate of 25 feet per minute would have a capacity of about 120 bushels per hour and when handling average stock would require the services of six efficient sorters. On this basis a separate sorting apron would be required for each 1,200 bushels handled per 10-hour day. Such an arrangement provides for the most efficient utilization of equipment. In some factories visited the arrangement was so poorly planned that the apron was running ten times faster than was necessary for handling the volume of stock. In other factories the tomatoes were run through at from five to six times the normal capacity of the machine and the number of sorters was insufficient to handle them under proper conditions.

SORTING SYSTEMS THAT HAVE FAILED.

In the past the practice of making pulp from peeling-table waste was not uncommon. Much of this pulp, in a more or less concentrated condition, was placed in barrels and disposed of for making cheap ketchup. The careless methods employed resulted in many condemnations of the product under the Federal Food and Drugs Act because the product was decomposed, in whole or in part. As a result of the Government's campaign against adulterated tomato pulp, some of the evils of the practice have abated.

The pulp commonly used for low-grade ketchups sold at from 75 cents to $2.50 per barrel, most of it selling for from $1 to $1.75. At these prices the manufacturer received only about enough to pay for the disposal of the waste which otherwise was an item of expense. When it is realized that the stock from which tomato pulp is made may contain 20 per cent of rotten tomatoes and yet not give to the finished product such plain evidences of their presence as to be detected by the average consumer, it is easy to understand the temptation and opportunity for negligence and carelessness in the manufacture of the product.

Some firms, by modifying their methods of manufacture, have been attempting to produce from trimmings an article which would be satisfactory under pure-food laws, but only a few have been successful, and these only in part. An examination of the prosecutions brought against adulterated tomato products during the last six years will show that most of these products were made from trimming stock. A recognition of these facts has raised the question whether it is possible to make a satisfactory pulp from the trimmings. It is possible to do this, but the added labor required makes it doubtful whether it is profitable. As the tomatoes must be sorted and handled

with unusual care if the trimmings are to be used for pulp, about one-eighth as many sorters as peelers must be employed.

Various methods have been tried unsuccessfully in different plants in the hope of avoiding the labor and expense involved in a thorough sorting of the stock before it passes to the peeling tables. An account of the least successful methods follows.

One method consists in furnishing each peeler with two buckets, one for sound trimmings, the other for decayed portions. The peelers are paid only for the peeled tomatoes. Hence, very little or no attention is given to sorting the good from the bad portions of the trimmings. Even if the sorting were done carefully there would still be the objection that the good portions had been contaminated by contact with the partially rotten portions during the handling after scalding and before peeling.

Another method tried by some manufacturers is to rinse the trimmings themselves. This is unsatisfactory for the following reasons: The washing results in a great loss of material; the trimmings on account of their bulk can not be washed effectively; and no washing system has been devised which will remove certain types of decay.

A third method is to inspect the trimmings after they leave the peeling tables and to remove the bad portions. A small proportion can be picked out in this manner, but the amount is so small that the system is of very slight value. After a large number of cut pieces, such as occur in trimmings, have been dumped together it is a physical impossibility to sort out any but the more solid portions, such as large pieces and those of dry or black rot. The pieces of soft rot become mashed and contaminate the whole mass and can not be removed.

UNIFORMITY AND RATE OF FEEDING.

The rate at which the tomatoes are fed upon the apron is an important factor in the efficiency of sorting. Tomatoes frequently are fed so irregularly that it is impossible to obtain good results.

Observations were taken at several plants for the purpose of determining what variation occurs in feeding the tomatoes to the sorting apron. The data from one of these inspections are given in Table 3.

TABLE 3.—*Variation in rate of dumping tomatoes into the washer.*

Time.	Bushels.	Time.	Bushels.
First 2 minutes	8	Next 6 minutes	0
Next 3 minutes	0	Next 1½ minutes	4
Next 2 minutes	9	Next 1½ minutes	0
Next 1 minute	0	Next 1 minute	4
Next 1 minute	4	Next 9 minutes	0

This series of observations, which extended over a continuous period of 28 minutes, shows a variation of from 0 to 4½ bushels per minute. The table shows that during the 28 minutes there were five periods of from 1 to 9 minutes each (aggregating a total of 19½ minutes) during which no tomatoes at all were dumped into the washer. From the washer the tomatoes were removed by a conveyor to the sorting apron. This tended to equalize the variation somewhat, but there was still great irregularity as the tomatoes were delivered finally for sorting. Although the average rate was only about 66 bushels per hour, there were periods when the observed rate amounted to 270. Such variation makes it practically impossible to obtain uniform results in sorting.

In dumping directly on the sorting apron the workmen often become careless and the tomatoes pass to the sorters in piles interspersed with vacant areas. In some plants one of the workmen is assigned to the task of regulating the rate at which the tomatoes are fed from the dumping board to the apron, but even this is not wholly satisfactory. An attempt has been made to overcome this difficulty by providing a mechanical device in the form of a feeding hopper, and although this device has not been tested thoroughly, it gives promise of relief. This feeding hopper consists of a short conveyor 18 inches wide and about 42 inches long, inclosed at the sides by boards extending 6 inches above the apron. It is so regulated that it travels 3 feet per minute. The conveyor or hopper thus made is kept rounding full and so placed as to deliver the tomatoes to the sorting apron with as little drop as possible. With these specifications as to size and speed, such a feeder, if kept full, will deliver 120 bushels of tomatoes per hour to the sorting apron at a regular speed. This is about the amount that can be handled satisfactorily on a sorting apron operated by 6 good sorters. Although this device as yet has been tested only in an experimental way under factory conditions, the results appear encouraging.

TURNING DEVICES.

For good sorting it is important that during the process all sides of each tomato be subjected to inspection. In 1911 the writer pointed out[1] the desirability of a mechanical device to turn the tomatoes over while they are on the apron. Some firms manufacturing machinery and several packers have undertaken to accomplish this in various ways. Of the forms applicable to the simple apron a certain device used in one plant has such merit that a description of it should prove valuable. Its simplicity, cheapness, and effectiveness, together

[1] Tomato Ketchup under the Microscope. U. S. Dept. Agr., Bur. Chem. Circ. 68, Feb. 13, 1911.

with the fact that it can be made by the mechanic of almost any plant, are important points in its favor.

For an apron 18 inches wide, 14 pieces of ¾-inch iron pipe (1 inch outside) were cut, each piece about 7 inches long. About one-half inch from one end of each piece a hole was drilled through the pipe large enough to permit of the pipes being strung on a ¼-inch steel rod. In order to insure freedom of movement a thin washer was placed between each pipe and the one next to it. The whole set was then suspended by means of the steel rod across the sorting apron with the lower ends one-half inch above the apron. A back-stop rod is put in behind the set to prevent the pipes from swinging back past the center. This was found necessary to prevent them from swinging so far back as to strike and gouge the oncoming tomatoes. Plate II shows a sorting apron fitted with three sets of pipes, thus allowing for one set between each pair of sorters. In operation the weight of the pipes is sufficient to roll the tomatoes over as they pass under.

In order to obtain satisfactory operation it is most important that the tomatoes do not cover more than 50 per cent of the apron area, otherwise they do not have room to turn properly. A test at one plant showed that 70 to 80 per cent of the tomatoes were turned each time they passed under a set of the pipes. It was found also that this turning device worked better on the open metal apron than on the canvas or rubber type, owing to the fact that the tomatoes slipped badly on aprons made of canvas or rubber.

LIGHTING THE SORTING TABLES.

The matter of providing suitable lighting for efficient sorting often has been neglected. In all too many instances there are no top lights, no provision is made for artificial lighting on dull days, or the workmen stand in their own light or labor under similar difficulties. Sorting requires quick observation and action and the workmen should have every possible advantage. Certain manufacturers have expressed gratification on noting the increased facility with which the tomatoes on the apron could be examined after their plants had been lighted properly.

The tomato-packing season comes at a time of the year when many days are cloudy. Hence, in planning an equipment provision always should be made to meet the most unfavorable conditions. The most desirable form of light is top light. This usually can be obtained at small expense by putting in a skylight. Where this is impracticable, two 100-watt electric lights with good white reflectors suspended 4 feet over each table give satisfactory light. In order to make provision for dark days it is desirable to have some such form of artificial lighting, even when the sorting room has a skylight. The

lighting should be so arranged that the shadows of the workmen do not fall upon the table. The walls and ceiling of the sorting room or shed should be painted white or whitewashed.

SELECTION OF SORTERS.

Greater care should be exercised in the selection of sorters than in the selection of any of the other laborers connected with the manufacture of tomato products. Some packers apparently have made the mistake of thinking that anyone who was not definitely employed elsewhere was good enough for sorting. Sorters, however, should be men or women (women usually have proved more satisfactory) old enough to be responsible and dependable, young enough to be still active and energetic. Young people not thoroughly responsible should under no conditions be intrusted with this important work. More harm can be done by one or two careless persons at the sorting apron than almost anywhere else in the plant.

The work is of a kind that requires perhaps closer attention and application than any other work about the plant, and might well be called "skilled labor," since efficiency in producing the best results comes from practical experience. Because of the close attention required of the workers it is one of the most fatiguing operations about the plant, and it is believed that a small bonus per hour to the persons selected to do this work would serve as an incentive to more painstaking work. In some factories visited, however, the sorters were paid only half or two-thirds as much per day as the peelers. Such shortsightedness in factory management is certain to lead to dissatisfaction and carelessness.

Because of the fatiguing character of the work, it would be wise where feasible to work the sorters in shifts of not over three hours each. The sorting should be superintended by a person who has proved himself highly efficient in that line of work or by one who is alert and has a discriminating mind and is able to handle workmen tactfully.

Where the simple apron system is used it is best to place the most efficient sorters last, in order that the final inspection may be made the most critical.

VOLUME SORTED.

The volume of tomatoes handled by one sorter is dependent upon several factors, among which the most important are the condition of the tomatoes, the system of sorting used, and the efficiency and experience of the sorter. With average stock it is impracticable to get good results by the table system if the tomatoes are delivered at a rate of more than 5 to 8 bushels per sorter per hour. With the

apron systems 20 to 25 bushels per sorter per hour have been about the practical limit for obtaining uniformly good results. Packers heretofore have given this point far too little consideration. It has been observed in some factories that the tomatoes were passing through at the rate of 200 bushels per sorter per hour. It is quite evident that little or no benefit can result from the operation of a sorting table under such conditions.

In order to impress upon producers the importance of handling the crop properly, some packers have put into operation a "loss-off" system by which they pay for the tomatoes on the basis of the sound tomatoes, allowing the presence of only a nominal proportion of spotted ones.

EFFICIENCY OF SORTING.

Practically all plants have some kind of sorting system, but experiments and observations in different plants show a wide variation

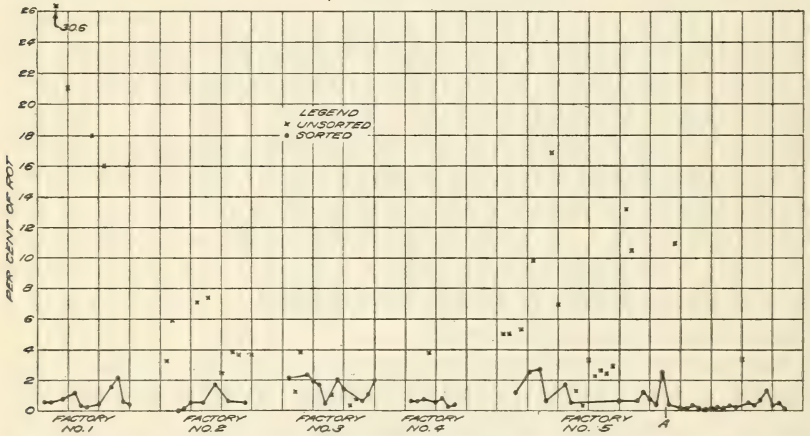

FIG. 1.—Efficiency sorting chart. Each cross or dot represents the result of an individual test and indicates the percentage of rot found.

in the efficiency of such systems. In some plants the sorting is done effectively, while in others the work is performed so poorly as to be practically valueless.

In order to obtain a numerical expression of the efficiency of sorting, the following method was employed: To secure the samples small portions of the stock were taken from the stream at intervals of about 15 seconds until a total sample of 20 to 40 pounds had been secured. The tomatoes in the composite sample were then examined critically for decayed portions. The objectionable parts were cut out, weighed, and their percentage calculated. Tests made under a variety of conditions in different factories showed that with proper equipment and control the percentage of decay can be maintained at 1 per cent or less. For purposes of com-

parison tests also were made on some of the unsorted stock. The results of the tests from a few typical plants are shown graphically in figure 1. The tests at each factory are plotted in the order made, but they were not made at equal intervals.

Factory No. 1 illustrates a case where the stock used was of very poor quality but, owing to the excellence of the sorting and washing systems, the decay was kept down to an average of 0.8 per cent, although two or three of the tests ran rather high.

Factory No. 2, which had experienced trouble in producing a sanitary product, adopted in 1916 a system of sorting and washing that very much improved the character of the product. In this case the average of the tests made for amount of rot was 0.5 per cent, with one test running up to the high point—for sorted stock—of 1.7 per cent.

The table system of sorting was being followed at factory No. 3. The work, however, was done so ineffectively that tests on the sorted stock showed about 1.4 per cent of rot as against about 1.5 per cent for the unsorted, so that there was practically no improvement. The average amount of rot present was one and three-quarters times as much as in factory No. 1, although the condition of the unsorted stock at factory No. 1 was fourteen times as bad as at factory No. 3.

At plant No. 4 the conditions as to sorting were found in 1910 to be very unsatisfactory. Since that time extensive experiments have been made, until in 1916 the improvement shown in the chart was observed. The average of the seven tests made on two days was about 0.5 per cent.

The chart also shows the result of tests made during three days at factory No. 5. At the beginning of the experiment the plant had a number of serious defects in its sorting system. Later, several changes were made in the system and the factory was operated on a more approved method with striking results. The point when the changes were adopted is shown in figure 1 by the letter A. The average of the tests on the sorted stock prior to A was 1.26 per cent of rot; of the tests made subsequently, only 0.28 per cent.

Data collected in many factories showed that in samples of unsorted stock examined the percentage by weight of rotten material varied from practically nothing to over 30 per cent, while the average in the whole series was about 5.5 per cent. The percentage of rot in the sorted stock (including the badly sorted as well as the thoroughly sorted) varied from practically zero to over 7 per cent, while the average was about $1\frac{1}{3}$ per cent.

The percentage of rot by number was also determined during the season of 1916 in most places in addition to the percentage by weight. Although not so reliable as the determination by weight, it does at

times serve as a quick, rough method of arriving at a knowledge of the character of the stock.

The data obtained show that on unsorted stock the percentage by number of tomatoes with rotten spots is approximately six times as great as the percentage by weight of decayed material. In seeking to estimate the proportion of decay in this manner, however, in the practical testing of stock the results can be regarded only as a rough approximation, since the variation in individual cases is very wide, ranging from a ratio of about 2 in some cases to 15, and in a few instances even higher than this. If this method is to be used in a practical way it should be used only where the percentage by number of decayed tomatoes does not exceed about 15, since even in that event it would indicate very roughly 2½ per cent of rot by weight. The factor, as a rule, becomes smaller as the percentages increase, owing to the relatively higher proportion of tomatoes with large spots. In the samples of sorted stock the average ratio of percentage of spotted tomatoes by number to percentage of rot by weight was about 10 to 1.

These relationships indicate that the rotten or spotted condition in unsorted stock averaged one-sixth of the mass of the tomato in which found, while in the sorted stock it averaged about one-tenth of the mass.

COST OF SORTING.

The question of the cost of sorting is important to the manufacturer. The wage commonly paid for this type of labor is about 15 cents per hour. The output by the table system of sorting ranges from 5 to 8 bushels per sorter-hour. Hence, the minimum cost by this system is about 2 to 3 cents per bushel. The investment for sorting equipment in this system is practically nothing.

By the apron system, good effective sorting can be made at the rate of 20 bushels per sorter-hour, thus reducing the labor cost to about three-fourths of a cent per bushel. This is simply for the removal of the tomatoes that are more or less decayed and that must be trimmed if any part is to be retained for use. The trimming process itself is believed to be usually a self-paying proposition.

TRIMMING.

Some packers have been observed to discard the whole of any tomato that showed a decayed spot. Tests made under factory conditions, however, prove that this is a wasteful practice, since the average amount of decay on unsorted stock is only about one-sixth of the whole tomato. Hence, to remove absolutely all traces of decay from each tomato, usually less than one-third of the tomato would need to be cut out. The remainder of the tomato would be entirely

suitable for use. In the apron system, however, it is strongly advised that if trimming is to be practiced it be done by a different set of employees from those who do the sorting, for if the sorter is required both to sort and trim at the same time his attention will become divided and he will pass many bad tomatoes.

Tests made at one plant where the work of sorting and trimming was done by two sets of workers showed that one trimmer reclaimed 43½ pounds of good stock in 25 minutes, or 104.4 pounds per hour. At the price then paid for tomatoes the quantity that was saved compensated for more than one-third of the expense of the efficient sorting and trimming being done at the plant.

PULPING.

The pulping systems in use may be classified as (*a*) cold and (*b*) hot. By the cold system the tomatoes are not cooked, but are put through the cyclones before or after passing through a chopping or crushing device. This is the usual system followed in making pulp from trimmings, although the scalding of the tomatoes for peeling slightly cooks the surface tissues. When the stock is scalded for peeling, and occasionally for whole-tomato pulp, the light cooking makes possible a cleaner separation of the pulp from the skin than is secured by the typical cold method.

By the hot system the tomatoes are partially cooked before going to the cyclone. This cooking undoubtedly gives a larger yield of pulp from the stock and tends to arrest or decrease the growth of microorganisms. Some manufacturers claim that they obtain a redder product by the cold than by the hot system, but the observations of the bureau seem to indicate no marked difference in the color of the product that may be attributed fairly to either system.

PULP-MAKING SYSTEMS.

The only places where the making of satisfactory trimming pulp has come under the observation of the department are those factories in which the tomatoes for canning were very carefully sorted before going to the peeling tables. This is done preferably before the tomatoes have been scalded, as after scalding they are too hot to be handled with any comfort, even when given the customary "chilling."

Some canners had the sorting done by men who had some other duties around the scalder or washer. This, however, is very undesirable, for if satisfactory results are to be obtained it is important that even more critical sorting be maintained than in the making of whole-tomato ketchup or pulp. This necessity for care is equally applicable to all the details of pulp making, such as method, speed of apron, capacity, personnel, and efficiency of the sorters, and prompt-

ness in handling the product. When proper attention is given to these details a satisfactory product can be obtained, but it is in the exercise of the care required that many packers have failed.

Why should the manufacturer desire to turn his trimming waste into pulp? Tests made at various factories have shown that 30 per cent or more of the weight of the tomatoes as received at the factory goes into the waste known as trimmings. An examination of ordinary trimmings shows them to consist of: (*a*) the skins from peeled tomatoes; (*b*) the stems and coarser part of the cores from around the stem end of the fruit; (*c*) the decayed and rotten parts cut out from the otherwise good fruit; (*d*) tomatoes wholly decayed; and (*e*) small tomatoes, and others of such size or shape that it would be unprofitable to skin them. If the trimmings were in good, clean condition, it is probable that no serious objection could be raised against pulp made from (*a*), (*b*), and (*e*), provided the packages were properly labeled to indicate the origin of the product.

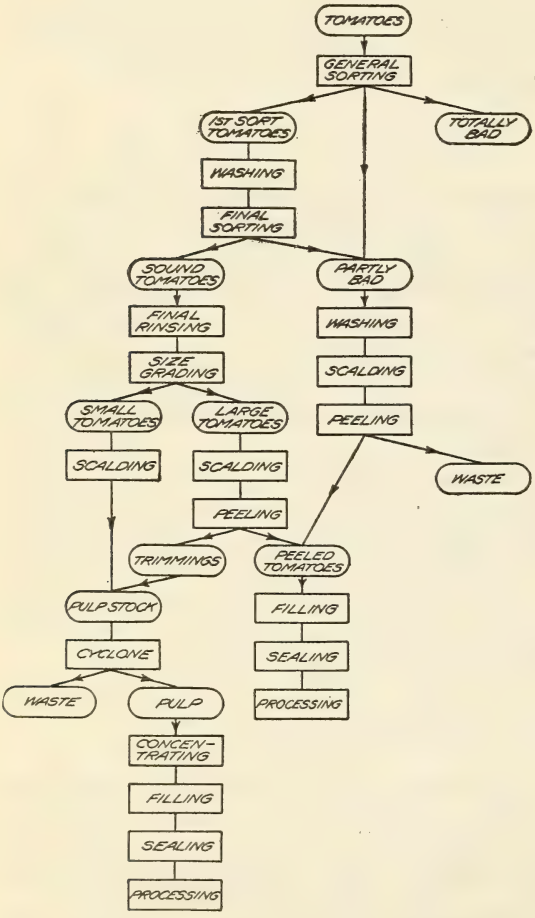

FIG. 2.—Diagram of system for the manufacture of tomato pulp from sound tomato trimmings.

Figure 2 shows graphically a system for manufacturing pulp from tomato trimmings. Although when properly handled such a system should give a satisfactory product, it is complicated, and the extra labor required in the use of trimmings in the pulp may not in average seasons be compensated by the value of the product resulting.

Because of the fact that a considerable part of the waste comes from small tomatoes which the peelers find it unprofitable to skin,

it has been suggested by some manufacturers that they might, at the start, pass their stock over a mechanical grader to remove all the small tomatoes before the peeling stock goes to the scalder. These small tomatoes could then be put through the proper processes for pulp making while the regular trimmings from the peeling tables would be totally discarded. Figure 3 is a graphic representation of such a system. Although this system appears reasonable and has been tested out by a few firms, sufficient data are not yet available to show its practicability as a commercial proposition. It is much simpler than the system shown in figure 2 and yet provides for the utilization of a large part of the sound portions usually lost in the trimmings.

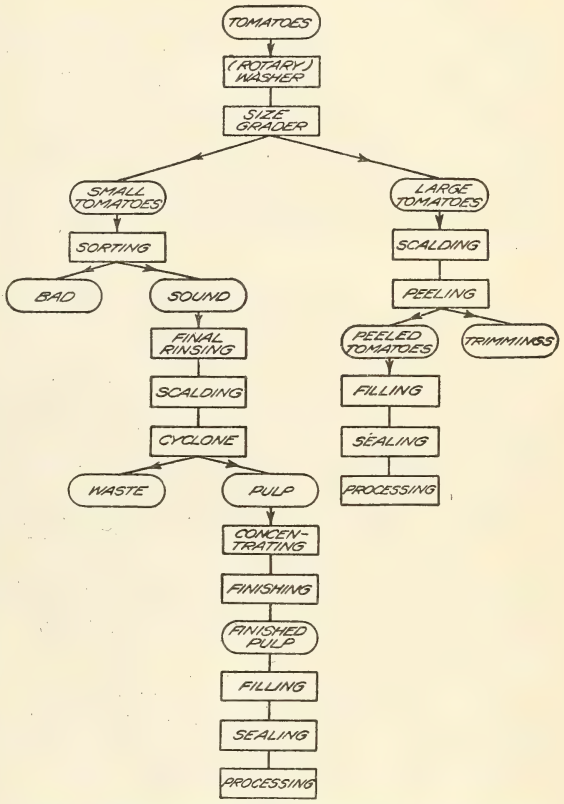

FIG. 3.—Diagram of system for the manufacture of tomato pulp from small tomatoes.

PROMPTNESS IN HANDLING STOCK.

The attention of manufacturers has been called repeatedly to the importance of the prompt handling of tomato stock, especially of the pulp after the sorting, washing, and pulping processes have been started. One of the greatest objections to the old "gravity system" is the delay occasioned at a stage when conditions are most favorable for rapid multiplication of the organisms. In this system stock that otherwise might be satisfactory is held for a period of time under conditions nearly ideal for rapid growth of organisms, especially bacteria and yeasts.

By the gravity method the stock before pulping usually is warmed more or less, according to the fancy of the manufacturer. After pass-

ing the cyclone the pulp is allowed to stand in a tank or vat. In half an hour or so the clear juice begins to separate from the fibrous cellular portions, which tend to rise, owing to the entangled gas. When this stage is reached a stopcock or bung near the bottom of the vat is "cracked" and the juice drawn off. Meanwhile, more pulp usually is added. In this way the pulp is held for varying lengths of time up to half a day or more, which obviously allows some spoilage to take place. Another objectionable feature is that a large part of the soluble solids, which contribute much to the flavor of properly made products, is thrown away. The rapid decline in the use of the gravity method during the last few years, therefore, marks a decided advance in the manufacture of tomato products.

Manufacturers should seek to reduce to a minimum the time required to carry the product through from basket to bottle or can. The slogan "An hour from basket to bottle" expresses a degree of efficiency which should be striven for by every manufacturer and which already is being attained in some factories throughout the country.

CLEANLINESS IN THE FACTORY.

ITS IMPORTANCE.

A knowledge of the conditions favorable for growth of microorganisms serves to emphasize the great importance of cleanliness about a canning factory. To secure normal growth there must be first the spore or a portion of the vegetative part of the organism to start the infection. Then for its development or multiplication there must be a suitable food supply, moisture, and a certain amount of heat. The rate of growth varies for different organisms and is influenced greatly by the nature of the food supply and the degree of heat.

One of the most persistent species of mold occurring around tomato-canning factories is that identified as *Oidium lactis* (Plate I). Molds growing on apparatus impart to it a slippery feel, very different from that which characterizes clean apparatus. A deposit of more or less cheesy consistency usually can be scraped from apparatus having such a feel.

Mold will grow sometimes in many unexpected places, such as on metal and wood conveyors, on cyclone paddles, and in similar places. As its presence always indicates lack of thoroughness in cleaning, it will be seen that proper cleaning is of vital importance if a sanitary condition is to be maintained in the plant. By proper forethought in planning and equipping a factory the difficulties in keeping it clean can be reduced greatly. It frequently happens that in devising, selecting, and installing factory equipment too little thought is

expended in seeing that all parts are so built and placed as to be easily accessible for cleaning. For instance, cyclones which as designed by the makers could be readily cleaned, have sometimes been so installed that effective cleaning was almost impossible. All parts should be accessible for scrubbing, as hose or steam alone can not be depended upon. Care should be exercised to avoid as far as possible all unnecessary angles resulting from careless lapping or matching of parts. Rounded corners can be used at times to great advantage.

THE NECESSARY EQUIPMENT.

An inspection of the equipment of some plants often discloses a striking lack of cleaning apparatus, such as water taps, hose, scrub brushes, and brooms. There should be adequate hose facilities for quickly and effectively flushing out machinery and floors. Three or four lines of hose and connections conveniently placed are none too many for an average canning factory. Many factories now have water connections by faucet or short hose within ready reach of each peeler. Such an arrangement allows each worker to clean quickly her own part of the equipment.

A steam hose also should be available. Some persons, however, have been inclined to put too much faith in the efficacy of the steam hose. If intelligently used on machinery that already has been properly scrubbed, it does excellent work in cleaning out loose material from crevices and in sterilizing and heating the metal parts so as to produce quick drying. For cutting out mold and slime on broad surfaces, however, a steam hose usually is insufficient. The average workman is likely to use it for too short a time and on too limited an area.

An ample supply of brushes—not simply one or two—should be readily available. The water-soaked brooms used in some factories should be replaced by stable brushes with stiff, split-rattan or steel-wire bristles. For cleaning wet floors such brushes are easier to use than brooms and are far more effective, as they cut the dirt and slime. The hand brushes also should be of some stiff material which will not, after being used a few times, become water-logged and mat down and simply glide over the surface without loosening the slime. Painter's triangles for reaching into and scraping difficult corners also have been found helpful. One or more flashlights would be of service for inspection and for working in obscure places.

USE OF EQUIPMENT.

After an adequate cleaning equipment has been installed a well-systematized plan of operation must be put into effect. Each workman should have an active part in this system. The most effective method for cleaning the floors is to assign three or four active men to

the task. One of these men handles the hose, directing the water where needed; the others loosen the dirt with stable brushes and give the final cleaning. In this way a large area can be cleaned quickly and effectively.

At one plant of moderate size such a plan was observed under operation. The periods immediately preceding luncheon and at the close of the working day were set aside for cleaning. The employees worked with such a degree of system that in 10 minutes the sorting table, washing and scalding machines, peeling tables, buckets, filling machines, cyclones, finishers, and floors were given a thorough cleaning. The reasons for this efficiency were that plenty of water was available, the apparatus was located conveniently, and each person had his or her part of the work to perform. Each woman cleaned her buckets and pans and her part of the peeling table, the sorters cleaned the sorting table, and washing and scalding outfits, while the pulp men were held accountable for the cleaning of their equipment. At the same time those working at the filling and capping machines cleaned their respective outfits. While these operations were going on several men had started flushing and scrubbing the floors at places where they would least interfere with the other employees, and as soon as the others had finished their cleaning the remainder of the floor was finished. The drains were so located as to help facilitate the entire operation.

If any part of the room had not been properly cleaned it was an easy matter to fix the responsibility, since each person had a definite work to perform.

Apparatus if well cleaned should, when wet, be free from any slippery or slimy feel and when scraped should not yield a cheesy deposit. At the close of the day's work the equipment after being cleaned should be left in such position as to permit of ready drainage, ventilation, and drying. These precautions will tend to check the growth of microorganisms. Pails, pans, and buckets should not be stacked, as is frequently done, and the cyclones, as well as the tanks and vats, should be left open.

PSYCHOLOGY OF CLEANLINESS.

The old adage "Like begets like" is applicable in factories as well as elsewhere. Where there is intelligent and tactful demand for cleanliness on the part of the factory management there is certain to be a conscious or unconscious response on the part of the employees. A workman has small incentive to adopt cleanly methods, however, if filthy, slovenly, or unsystematic conditions about the factory are the rule. Workmen usually prefer employment in clean surroundings. One factory owner who maintained his plant in good

condition reported that instead of having a shortage of suitable help he had on file a waiting list which enabled him to fill any vacancies on his force with selected help, although some factories near by were finding it impossible to get sufficient help.

The factory might well be regarded as a cooperative institution and the employees made to feel that its welfare is a part of their personal concern. Clean dressing rooms, clean, sanitary toilets, and simple provisions for caring for emergency accidents will be appreciated by nearly all the employees. But in order to attain such an esprit de corps the superintendent or manager himself must be foremost in planning and systematizing the work of cleaning, which must be begun at the opening of the season and tactfully enforced throughout the entire season if it is to prove successful.

LABORATORY CONTROL.

From the standpoint of law enforcement, laboratory methods of examination are necessary, since there is no other way by which the officials on whom rests the responsibility for enforcing the law can judge correctly whether the product complies with the law's requirements. Without the check afforded by laboratory methods the product of insanitary factories would come into open competition with sound and good products, and in such condition that the consumer usually would be unable to detect its true, offensive nature.

Large manufacturers who have analysts thoroughly well-trained in microscopical methods have also found laboratory supervision of great value as a means of checking the work of their sorters and superintendents. The fact that the character of their work can be determined from an examination of the finished product is a strong incentive toward inducing employees to exercise a greater degree of care in the various details of manufacture. It is well also for the analyst to check his work from time to time with that of other reliable analysts in order to keep his own operations in agreement with those of others in the same line. No conscientious analyst would undertake to do careful analytical work for a manufacturer before he had proved himself reliable through experience with the product and through checking his findings with those of other analysts, known to be reliable.

The manufacturers also may test the ability of their analysts by submitting to them sterilized portions of the same sample at different times under different identifying marks. It is of the utmost importance, however, that the samples be exact duplicates, for if they have not been taken from the same batch after thorough mixing and then kept under sterile conditions the results are utterly worthless for purposes of comparison. It is the writer's belief that some

of our food manufacturers view this question of laboratory control from an entirely wrong angle. It is thought that there are some manufacturers who use it simply as a means of trying to get their goods to "pass inspection." Instead of seeking to make the best product possible the temptation is to make a product just good enough to escape adverse action on the part of the food-control official who examines it. It is not to be inferred from this statement that any large number of American manufacturers consciously take this attitude, but such a result is always likely to follow whenever a definite standard for a product is proposed in any line of business.

The Department of Agriculture desires to emphasize in this bulletin the supreme importance of certain methods and elementary steps in manufacturing as prerequisites in the production of sanitary goods. As the analyst for a firm once said, "If the objectionable material has been kept out during manufacture, no laboratory test will find it present when the finished product is in the bottle." If proper attention has been given to the necessary details of manufacture, no laboratory examination should be needed, while, on the other hand, if such details have been slighted, no amount of laboratory work can correct the evil and make the product one that can be classed as sanitary and worthy to be put on the market for consumption.

SUMMARY.

In recent years great changes have taken place in the methods of manufacturing tomato products, such as the abandonment of the "gravity system" and of storage in barrels, and the introduction of careful sorting systems.

Many manufacturers believe their plants are sanitary and do not know why their products show impurities. Examination of several factories showed defective methods of cleaning the apparatus; in other places inadequate sorting methods were found responsible for insanitary products.

The method of washing should be determined by the character of the soil in which the tomatoes are grown.

Too little attention usually is given to sorting, although it is probably the most important step in the manufacture of clean, wholesome tomato products. Only skilled, responsible workers should be intrusted with this task, and, preferably, should be worked in shifts of not over three hours. If an apron conveyor is used, the speed should be carefully regulated to the capacity of the sorters. Care should be taken to have the feed uniform. The sorting room should be lighted from the top and incandescent lighting should be provided for dark days.

Trimming and sorting should be made separate operations.

It is very difficult to make sanitary pulp from trimmings alone and its manufacture is of doubtful profit even when properly done.

It is possible to arrange a system of manufacture by which the rotten trimmings can be wholly discarded and the pulp made from good trimmings and small tomatoes.

The percentage of decay in the sorted stock should be 1 per cent or less.

Prompt handling is essential if spoilage is to be avoided.

Too much care can not be given to cleaning. Every piece of apparatus in the factory should be arranged conveniently and plenty of cleaning equipment should be available. The best results are obtained when the cleaning is highly systematized and each worker is made responsible for his part in it.

Laboratory methods of checking the character of the finished products have been found of great value.

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